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Ringing in the 20th Century

The Effects of State Monopolies, Private Ownership, and Operating Licenses on Telecommunications in Europe, 1892–1914

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For many countries, recent reforms in telecommunications represent a restoration of the private provision and competition that prevailed in the early part of the 20th century. At that time, just as today, telephone service in countries with competing private providers was superior to service in countries with a state-owned monopoly.

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Summary findings

Countries around the world are liberalizing their telecommunications networks by privatizing incumbent state-owned firms and introducing competition. For many, this change represents a return to private provision and competition—not a new phenomenon. The beginning of the 20th century saw great variation in the structure of telecommunications sectors, with some countries operating state monopolies and others—especially in Scandinavia—allowing vigorous private competition.

Wallsten uses data on countries around the world in 1913 and on European countries in 1892–1914 to test the effects of government monopolies, private provision, and operating licenses on telephone development. Controlling for per capita income and, where possible, for country and year fixed effects, he finds that state monopoly provision is correlated with substantially lower telephone penetration and higher consumer prices for long-distance service than private provision. Contrary to conventional wisdom, rural service was also worse under state-owned monopolies. Operating licenses that gave the state the right to appropriate firms' assets similarly led to lower telephone penetration and higher prices.

This paper—a product of Regulation and Competition Policy, Development Research Group—is part of a larger effort in the group to examine the effects of telecommunications privatization and liberalization in the developing world. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Paulina Sintim-Aboagye, room MC3-422, telephone 202-473-7644, fax 202-522-1155, email address psintimaboagye @worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at swallsten@worldbank.org. October 2001. (32 pages)

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Introduction

The last decade has witnessed dramatic changes in telecommunications sectors around the world. Both industrialized and developing countries are privatizing state-owned incumbent telecom providers, introducing competition to the sector, and—especially in the case of developing countries where there was little—building regulatory capacity. The trend towards liberalization in modern telecommunications began in the late 1950s when the US Federal Communications Commission (FCC) allowed large firms to bypass AT&T, the monopoly telecom provider, with microwave transmission for long-distance service (Crandall and Waverman 1995). It gained steam in the 1980s when the UK's Thatcher government began a wave of privatization of state-owned firms (Megginson and Netter 2000). These efforts, in general, appear to be succeeding in improving telecom service. Competition tends to greatly improve telephone penetration, as does privatization in the presence of effective regulatory institutions (Petrazzini 1996;Wallsten 2001;Wellenius and Stern 1994).

Most empirical research on telecommunications begins studying the sector in the 1980s, which was when widespread reforms of state-owned monopolies began. But the trend towards privately-run telecommunications networks around the world actually represents a *return* to private provision, not a completely new phenomenon. Private firms (usually subsidiaries of the Bell telephone company) typically first introduced telephone service into countries in the early 1880s. Some countries quickly nationalized their networks, but others actively promoted private ownership and competition. As a result, telephone provision around the world in the late 19^{th} and early 20^{th} centuries was a mix of government and private ownership, where private ownership almost always meant a competitive market in the sense that multiple firms could obtain concessions within a country. Private firms often faced "regulations" through rules spelled out in operating licenses and concessionary agreements.

This paper combines historical data from several sources to test the effects of government monopoly ownership and regulation on telephone provision. Econometric analysis of cross-sectional data from 33 countries in 1913 and panel data on European countries from certain years 1892-1914 reveals that government monopolies lead to worse telephone penetration and higher prices, even controlling for per capita income and year and country fixed effects. Provision by private providers, meanwhile, could be severely hampered by capricious regulations (where "capricious" means that the government retained the right to take over the concession with no payment to the operator). The countries with the most liberal policies towards private provision—Norway, Sweden, and Denmark—had the highest telephone penetration in Europe through the entire sample period. Moreover, rural areas, which many people still believe would not be served under a competitive environment, had better service across Europe on average under private provision than under government monopoly.

The Telephone and the Telegraph

Conventional wisdom holds that an early belief that telephone service was a natural monopoly lead countries to prefer that one firm provide telephone service, which in Europe meant a state-owned, rather than a regulated private, monopoly. Indeed, network externalities mean that the total benefits of each new connection exceed the benefits that accrue to the newly connected person since everyone else can now reach that person. Achieving these benefits requires that each person to be able to reach every other person, which means that some sort of unified service is required to achieve the greatest benefits. However, it is not clear that there were economies of scale in supply in the early going. The number of possible connections increased exponentially with the number of telephones on the network, making manual switching increasingly costly with network size (Mueller 1997).

In any event, the early sector structure was not determined by policy analysis intent on maximizing welfare. Instead, it tended to be determined by how countries had handled telegraph service and how they viewed telephony relative to telegraphy. The first telegraph systems were *optical*, not electrical, and came into widespread use in Europe in the late 18th century. An optical telegraph system is essentially a series of stations, each equipped with a visual signaling system, placed as far apart as one could see with a telescope.[1] At each station a lookout would watch the neighboring station through a telescope, read the message being signaled, and then relay it to the next station. The French War Department began building an optical telegraph network in 1794, and by 1842 operated a 300,000-kilometer network. The War Department did not allow public access to the network. In 1833 a private firm opened an optical telegraph to the

[1] This technology was, even by the 18th century, probably ancient—there is evidence that Greece had an extensive network in place thousands of years earlier for use by its armies. Supposedly the Greek armies used an optical telegraph network to notify the capital that they had won the Trojan War in 1200 BC. (See http://www.athnet.ampr.org/~sv1uy/index.htm#optical for a discussion).

public, but the French government shut it down and in 1837 declared telegraphy to be a state monopoly. This law was then applied to the state's electrical telegraph, which first opened in 1845. The public did not have access to telegraph lines until 1850 (Holcombe 1911).

Across Europe, governments built state-owned electrical telegraph systems in the 1850s, though laws did not always explicitly prohibit private ownership. Denmark and Sweden were notable exceptions to state ownership of telegraph. The Swedish government did not give itself a legal right to provide monopoly telegraph service (Casson 1910). Though the Norwegian state did retain that right, it granted the Great Northern Telegraph Company a 30-year concession (Andersson-Skog 2000). This relative permissiveness continued into telephony, and by 1895 some 50 firms had telephone concessions in Denmark and by 1920 Sweden had some 100 firms. By 1906 both countries had about six times the number of telephones per capita than did France, while Danish per capita income was only about ten percent greater than French and Swedish income somewhat less.

Throughout Europe the relationship between the state and the telegraph system would become one of the most important elements determining the state's approach to telephony. Webb (1910, p.14) succinctly summed up the general story of Europe's initial experience with the telephone: "The telephone was taken to the Government Telegraph departments and offered for sale, but the Telegraph departments declined to take the risk of developing a totally new business. At the same time, however, they assumed control over the telephone and issued licenses to companies formed to exploit the new invention, these licenses being generally for restricted periods and surrounded by the most onerous conditions." Then, once it became clear that the public did, in fact, value telephone service, the government telegraph agency took it over.

Private firms—usually subsidiaries of the Bell Telephone Company—were the first to introduce telephony in Europe, as few governments anticipated the incredible demand for the technology. Alexander Graham Bell took his newly-invented telephone to England in 1878, but found little interest in it (Casson 1910). Britain's Postmaster General told Parliament that year that "it is evident that the instrument is at present unsuitable for the purposes of public telegraphy, and I do not, therefore, propose to introduce it in that branch of the Postal Telegraph Service" (Holcombe 1906). Several governments, whose telegraph departments viewed the telephone as just a "scientific toy," at best (Webb 1910), including Britain, Austria, Belgium, and France gave private concessions in the early 1880s (Bennett 1895).

The high public demand for telephony soon became apparent, and state telegraph agencies saw a potential threat to their revenues. Laws that granted the state the right to control the telegraph were quickly extended to include the telephone in order to protect the telegraph. Austria and Belgium nationalized its private providers soon after granting concessions, and France took over all private exchanges by force in 1889 when the firms refused to hand over their assets (Bennett 1895). Some countries that had not yet allowed any substantial telephone investment, including Bulgaria, Germany, Switzerland, and Luxembourg established state-owned monopolies.

The Differing Structure of the Telephone Sector

The first experiences with the telephone left countries in Europe with very different sector structures. Some countries cautiously allowed private firms to provide service under strict concessionary agreements. Other countries—the Scandinavian countries in particular—encouraged private sector investment and initially allowed firms the freest hand in building out their networks. The remaining countries provided telephone service through state monopolies. Governments that operated monopolies ranged from those like France that showed little interest in telephony, to those like Germany and Switzerland that saw the potential benefits of telephony. The sections below detail these different approaches.

Private service under harsh concessions: Great Britain, Italy, Spain

Some countries allowed private firms to operate under stringent conditions. Bell and Edison subsidiaries in Great Britain merged in 1880 to form the United Telephone Company (UTC). Though it held a monopoly concession, the firm operated in a harsh political environment. The British government had nationalized the telegraph system in 1871 and was concerned about recouping its investment (Bertho-Lavenir 1988). As a result, UTC's license allowed it to build lines only to 2-5 miles from any city center, required a royalty of 10 percent of gross receipts, and allowed the government to buy the system at an undefined "fair price" in

1890. When the government saw a decrease in telegraph revenues in 1882 it made the concession even more stringent: UTC had to sell the post office as many telephones as the post office wanted on terms fixed by arbitration, and was prohibited from building public call boxes. It soon became clear, however, that public sentiment strongly favored telephone development, and in 1884 Parliament revised the regulatory structure in hopes of stimulating competition. Under the new regulations, UTC's concession remained the same, but the government intended to also grant municipal concessions (Holcombe 1906).

Unfortunately, this policy failed to stimulate competition, as only six out of a possible 1,334 municipalities set up telephone exchanges in response to this new system (Holcombe 1907). There appear to be two reasons for this failure. First, the UTC, reorganized as the National Telephone Company ("National"), made competition difficult. Many of National's regional concessions covered multiple municipalities, meaning that cities felt they had to organize service collectively to compete effectively. Probably more importantly, however, was the fact that all concessions were set to expire in 1911, with no agreement as to what would happen afterwards. In 1904 National warned that it would not sign up new customers since it had to recoup all of its investments by 1911. By the end of that year 10,000 people were on the waiting list for telephone service. (Holcombe 1906).

Italy allowed private operation of telephony, though the state's overriding goal appeared to be protecting telegraph revenues. Indeed, the telegraph authority "reserved the right to require the telephone companies to make alterations when they should deem it necessary for the protection of the telegraph service at the companies' own expense" (Webb 1910, pp.366-367). Moreover, while concessions were granted for up to 25 years, the government could suspend them whenever it wanted and could completely revoke the concession after 12 years. At the end of the concession all the equipment would revert to the state without payment (Bennett 1895).

Spain began with a remarkably open approach to telephony. An 1884 law made telephony the exclusive domain of the government, but the state reversed itself in 1886, declaring that "so long as the telephonic service is administered by the State it can never develop and attain the proportions demanded by the necessities of modern life. Private enterprise, on the other hand, while adapting itself to public requirements, will find in this novel means of communication a vast field for activity in which apt initiative will be repaid by satisfactory development" (Bennett 1895, p. 323). In a move ahead of its time, Spain auctioned off concessions, where companies bid on the royalty they would pay the state, with the minimum allowed bid being 10 percent. The state ultimately granted 35 concessions, with the winning bids being a 10 percent royalty in the towns of Valladolid, Seville, Granada, and Alicante, 20 percent in Madrid and Saragossa, 31.5 percent in Valencia, 33.75 percent in Barcelona, and 34 percent in Bilboa. Unfortunately, the state also decreed that at the end of the 20-year concessions the entire system would revert to the state without compensation (Bennett 1895).

Private service in an open environment: Scandinavia

At the beginning of the 21st century Scandinavia is recognized as a center for innovative global telephony. It is much less frequently recognized that Scandinavia was already a global leader by the beginning of the 20th century. Bennett (1895) exclaimed that

> there would seem to something in the Scandinavian blood, to which the inhabitants of the capital and all the more important coast towns mostly belong, which renders the possession of many telephones an essential to their owners' happiness. Wherever two or three Swedes, or Norwegians, or Danes, or Finns of Scandinavian descent, are gathered together, they almost infallibly proceed to immediately establish a church, a school, and a telephone exchange. Whatever else in life that is worth having generally comes after." (p.130)

While perhaps best left to a non-economist to test "the Scandinavian blood," Scandinavian telecommunication public policies appear to have been well-designed to promote telephony. For example, Sweden, Norway, and Finland charged no royalties on private firms operating telephone network (Kingsbury 1915). And in an interesting twist on later divisions between local and long-distance service, the Swedish and Danish governments built and operated trunk lines connecting the many local independent private exchanges.

Sweden had no legal monopoly on telegraph, and the Bell company opened exchanges in Stockholm, Gothenburg, and Malmo in 1881. Local cooperatives began setting up almost immediately thereafter (Casson 1910), and by 1920 Sweden had almost 200 private telephone networks (Andersson-Skog 2000). Stockholm undoubtedly saw the greatest benefits from competition. The General Telephone Company, which started as a cooperative, quickly emerged as a major competitor of Bell in Stockholm, and soon bought out the Bell operation.

After the General Telephone Company bought out Bell, the state opened a competing exchange in Stockholm. Parliament, apparently concerned about the dangers of monopoly, until 1918 prohibited the state firm from buying private firms (Andersson-Skog 2000). Residents of

Stockholm benefited from intense competition in the early 1900s between the state firm and General Telephone. By 1914, Stockholm boasted 24 telephones per hundred people. This penetration rate compared to, for example, an average of 11.3 telephones per hundred people in the 12 largest U.S. cities, 6.6 in Berlin, 3.5 in London, and 3.2 in Paris (Kingsbury 1915).

The Danish government initially stayed out of telephony altogether, and Bell opened the first exchange in Copenhagen in 1880, selling out to the Copenhagen Telephone Company in 1882 (Bennett 1895). While the state possessed a legal right to a monopoly in telegraph and telephones, it allowed municipalities and other local authorities to grant private concessions as they wished. The state built long distance lines (in competition with the larger private firms), but otherwise stayed out of telephony.

The Norwegian story is similar. In 1880 Bell established exchanges in Christiana (the capital) and Drammen. The Christiana Telephone Company soon bought out Bell in that city. Bell also sold its Drammen operations to the Drammen Uplands Telephone Company, which then began extending its lines to rural areas outside the town. Bennet (1895, p. 281) noted that "the company has shown how a large tract of sparsely populated country, containing nothing larger than a village, can be telephoned and maintained year after year at a handsome profit."

The Norwegian government was not entirely accommodating at first, but ultimately did not block private telephone development. While an 1881 law gave the government the right to a monopoly in telegraph and telephone, it was also allowed to grant private concessions. The government made some early attempts to protect its telegraph system, mandating that telephone systems had to remain within 11 kilometers of a city center and prohibited cities' telephone systems from coming within 2 kilometers of each other (Webb 1910). But these laws quickly broke down as firms found ways around the restrictions. Indeed, the telegraph service began using telephone lines for telegraphy rather than build new lines.

Government ownership

As the analysis below will demonstrate, public ownership tended to generate worse outcomes than private (competitive) provision. In large part state telephone provision was poor because it was provided by the telegraph agency, which wanted to protect telegraph revenues. This was unarguably the case in France, for example, which as early as 1884 rejected one private concession because it did not provide "an adequate safeguard for the revenues from the public telegraph." The concessions that it did grant were short—typically four years in length—and restrictive (Bertho-Lavenir 1988). The government ultimately took control of all private networks by force in 1889. Telephone service did not improve—penetration remained low and prices high. In 1895 the French national telephone authority justified its high telephone rates as necessary to, as A. Lebon, the French minister in charge of telephone service said, "act as a 'dike' against an inconveniently rapid increase of subscribers and . . . have to be maintained until more ample facilities should be available" (Holcombe 1911).[2]

The French government, however, allocated little money to build those facilities. Instead, cities that wanted telephone networks were required to provide funds to the national government. which would then build the network for them. In practice, chambers of commerce organized to pressure local banks to make funds available for network development. The businesses responsible for this sort of organization, however, tended to be primarily interested in securing a line to Paris, not in building a local network (Bertho-Lavenir 1988). Telephone development in France remained seriously retarded as a result. While Denmark, Sweden, and Norway had 4.5, 4.1, and 3.4 telephones per hundred people by 1914, France could muster only 0.8.

But not all governments that operated telephone networks were so myopic. Germany and Switzerland both operated state-owned networks, and policymakers in both countries recognized potential benefits of telephony, viewing it as a complement, rather than a competitor, of the telegraph. Indeed, both countries saw telephone service as a way to extend their telegraph lines and favored early investment for that purpose (Holcombe 1911;Webb 1910).

Germany first introduced telephone service in 1877 as an "auxiliary telegraph apparatus," intended to bring telegraph service to suburban and rural areas. In 1879 Bell asked for a concession to build true telephone service, but the Post Office declared the telephone to be "technically immature and therefore incompatible with the technically more sophisticated system of the telegraph, and backers of state intervention, who stressed the threat to the Reich finance and danger of a loss of political and economic control to a foreign company, . . . decided to interpret the legal situation of the telephone as being part of the existing state monopoly on

[2] The French government was apparently a notoriously strict employer, as well. Apparently, operators were not allowed to marry without the Postmaster General's permission, and were not allowed to marry a "mayor, a policeman, a cashier, [or] a foreigner, lest they betray the secrets of the switchboard" Casson, Herbert N. 1910. *The History of the Telephone*. Chicago: A.C. McClurg & Co..

telegraphy that was fixed by the Constitution" (Thomas 1988, p.183). Telephone service thus languished, with little investment from the state beyond its complementary use for telegraphy.

Because it was primarily a means of enhancing long-distance telegraphy, penetration and local service suffered. As late as mid-1890s the local exchange in Berlin operated only from 7:00am until 10:00pm, while other major cities had around-the-clock service (Bennett 1895). Nor were individuals allowed to share service, which could have increased demand: German law made it illegal to lease a phone to neighbors, punishable by six months in jail (Casson 1910). Finally, service suffered when the state delayed introducing new technologies. Webb (1910, p.64) noted that "single wire overhead line plant was largely maintained in service in Germany long after metallic circuit working and underground cable distribution has been generally adopted in other countries."

It is clear that governments around the world, and in Europe in particular, took vastly different approaches to the introduction of telephony. In the remainder of this paper I discuss data from this early period and empirically test the effects of government monopoly provision and regulation on telephone service.

Data

The data I use in this paper come from several sources. AT&T was the first to compile detailed statistics on telephone penetration by country. I have the 1912 and 1913 AT&T reports (American Telephone and Telegraph 1912;1913), which report figures as January 1 of those years, while Kingsbury (1915) reproduced the 1914 figures. The 1913 and 1914 reports also provide penetration data separately for cities with populations greater than 100,000 and for areas outside those cities in selected (primarily European) countries. I pieced together earlier data from scholarly works, including Bennett (1895), Holcombe (1906;1907;1911), Casson (1910), Webb (1910), and Kingsbury (1915). These sources also provided information on the ownership and regulatory structure of each European country. Bennett (1895) proved an especially rich source: in addition to early figures on telephone penetration and descriptions of the sector structure in many European countries, he also compiled data on services and prices. Bennett's diligent and thorough efforts allow me to apply modern econometric techniques to test empirically the effects of the market structure on prices as well as on penetration. Finally, it is important to control for income in any cross-country test involving telecommunications. I thus obtained historical estimates of per capita income from Maddison (1995).

Telephone penetration and state/private provision

Table 1 shows 1914 worldwide telephone penetration statistics, including whether the government, private firms, or both provide telephone service.[3] The United States had by far the highest penetration rate in the world. There are several reasons for this dominance. First, the telephone was invented and first put to use in the U.S., giving the U.S. a head start. Second, telegraph service was privately provided in the US (by Western Union), meaning that the government did not face strong pressure from government agencies to protect that industry. Finally, once the Bell patents expired in 1894, thousands of competing telephone exchanges popped up around the country. Recent research demonstrates dramatic increases in U.S. telephone investment after the patents expired as Bell competitors emerged around the country (Gabel 1994;Gabel 1969;Jayakar 1999).

Figure 1 shows telephone penetration per hundred people and GDP per capita in Europe in 1914. The dominance of the Scandinavian countries in telephone penetration is clear, despite not being substantially wealthier than other European countries. The figure shows Great Britain—the wealthiest country in Europe—lagging far behind the leaders in terms of telephone penetration. Figure 2 shows telephone penetration per hundred people for selected years from 1885 through 1914. Again, the swift growth of telephone service in the Scandinavian countries is apparent.

Figure 3 shows similar information for selected cities in Europe and the United States from 1889 through 1914. Stockholm, Sweden with its vigorous competition between the private and the state-owned firm, reached 24 telephones per hundred people by 1914, more than double its closest European rivals, Copenhagen (Denmark) and Christiana (Norway). Telephone penetration in Stockholm exceeded many US cities: the average penetration rate in US cities with populations greater than 250,000 was only about 12 phones per hundred people. Figure 4 demonstrates that in 1894—the year Bell's patent expired and thus the last year of monopoly provision in the US—Stockholm, with its competitive environment, had almost four times the number of telephones per capita as Chicago and New York and double that of Los Angeles. Perhaps one of the more remarkable stories in Figures 3 and 4 is that telephone penetration in US

[3] The numbers are technically for January 1, 1914, and thus are statistics before WWI broke out.

cities was not so different from the major European cities with monopoly providers until after Bell's patent expired and competition broke out.

Prices and Services

As mentioned above, Bennett (1895) compiled copious information on services and prices for European telephony. Table 2 shows some basic prices for European countries, including prices for connection, subscription, and other services. The additional services, in particular, are striking. Today the literature is rife with discussions of a revolution in communications as technologies converge and telephone wires carry more than just voice. The early days of telephony, however, also saw greater uses for the telephone than just person-to-person voice communication. For example, telephone services in many countries at the end of the 19th century offered not just local and long-distance telephone service, but also telephonograms (as defined by Bennet (1895), "a message telephoned by a subscriber to the central office to be written down and delivered by messenger to a non-subscriber"), telephoning mail (a subscriber calls the central office where an operator writes down the message and mails it as a letter or postcard), and telephoning of telegrams.

While the differing structure of prices makes comparisons of many services difficult, it is easier to compare long-distance prices. Table 3 shows prices of long-distance service, in current pence, for selected European countries, derived from a table in Bennett (1895, p.16). While less difficult to compare than the prices above, several factors cloud the comparisons. First, some countries charge by the minute, while others charge in three- or five-minute increments. To facilitate the comparison I imputed each country's per-minute charge. Second, the price typically depended on the call distance, with prices increasing nonlinearly with mileage and at different increments across countries. The chart thus shows prices for calls covering distances ranging from 20 to 720 miles. Third, the maximum possible distance of an intra-national long-distance call differs by country, since countries are different sizes. Finally, Bennett (1895) undoubtedly also had to make assumptions to create his table, but it is not possible to know what those were.

Despite the table's shortcomings, it is clear that the Scandinavian countries generally have the cheapest prices, with long distance calls of any length included in the subscription price in Denmark, with Finland and Sweden close behind at a maximum of just 1 to 1.5 pence per minute beyond some distance. The UK had among the most expensive service, with prices increasing quickly, to a maximum of 41 pence per minute for calls that cover 720 miles.

Empirical Analysis

The goal of this paper is to explore the effects of market structure on development of the telephone sector. Research on current telecommunications reforms usually tries to untangle the effects of government ownership, privatization, and competition. Generally speaking, in today's parlance government ownership means a state-owned monopoly telecom provider, privatization means transforming the state-owned incumbent firm into a private monopoly (hopefully as just a first step towards greater liberalization), and competition means any firm that can somehow reduce the incumbent's market power. I use slightly different terminology in this paper, reflecting the different nature of the industry a century ago.

Nationwide monopolies were almost always government-owned, as few countries allowed private firms a nationwide monopoly. In other words, there were essentially two states of the world in telephone provision: (1) countries with state-owned monopolies, and (2) countries with multiple providers, sometimes all private and sometimes with a state-owned firm as one of the competitors. It is important to note that some countries with multiple firms would grant those firms regional monopolies. Unfortunately I do not have any consistent information on this phenomenon. There is also one exception to the "private equals competition" rule: the UK had a national private monopoly until the state took it over in 1911. However, the UK's 1884 regulation attempted to entice municipal competition, so the national telephone company faced the threat of potential competition across the country, and actual competition in a few cities. A more important issue in the UK, as mentioned above, however, may have been the restrictive concessions, which introduced substantial risk into telephone investment.

I do not have detailed cross-country information on regulations. This lack of information is, in part, because telephones were new and regulations, in the modern sense, scarce. But this scarcity in some ways makes the empirical analysis simpler because the most important regulation was likely the concessions under which private firms operated. For the purposes of this paper I note whether a country had "capricious" regulations, which I define as whether the country had the right to appropriate the firm's assets without compensation. The countries in the sample with concessions like that include Spain, Italy, and the UK (prior to 1911).[4]

Telephone penetration

To estimate the effects of market structure on the development of the telephone, I estimate several versions of equation (1).

$$(1) \quad telephone\ penetration_i = \beta_0 + \beta_1 * (government\ monopoly_i) + \beta_2 * (capricious\ regulations_i) + \beta_3 * (gdp\ per\ capita_i) + \varepsilon$$

As discussed above, telephone penetration is the share of population with a telephone.[5] *Government monopoly* is a dummy variable that equals one if the government owns the monopoly telephone company. *Capricious regulations* is a dummy variable that equals one if a private firm operates under a concession that allows the government to appropriate the firm's capital or withdraw the firm's license without compensation. Finally, the equation controls for national per capita income since it is typically—even today—the best predictor of telephone penetration in a country.

I first estimate the equation using cross sectional data from 33 countries around the world in 1913.[6] In this case I omit the regulation variable since I do not have that information for countries outside Europe. The first column of Table 4 shows the results of this regression. As expected, per capita income is positive and statistically significant: richer countries had better telephone systems, as is still the case today. The coefficient on the government monopoly variable is negative and significant. Controlling for per capita income, countries with government monopolies had, on average, almost 1.5 fewer phones per hundred people. This is an enormous difference, since the average worldwide penetration rate (in this sample) was only about 1.4 phones per hundred.

To begin focusing empirically on Europe, where I have more complete information, I run the same regression (for now ignoring regulations) using only the 18 European countries in my sample. The second column of Table 4 shows those results, which are consistent with the results

[4] Concessions in the UK did not actually allow the government to take over the system without compensation at the end of the concessionary period. Instead, the issue was that the government was not planning on renewing the concession after 1911 and had as late as 1904 had made no statement as to what would happen after that date.

[5] Even today this measure is the best available indicator of telephone access in a country.

[6] While AT&T (1913) provides information on more countries, GDP data was available for only those 33 countries.

discussed above. Per capita income is positive and significant. State-owned monopolies are correlated with worse telephone penetration—almost 1.2 phones per hundred worse, on average.

The third column of Table 4 shows the results of this estimation when including the "capricious regulation" variable. The coefficient on this variable is negative and significant, as is the coefficient on the government monopoly variable, which also increases in magnitude, from negative 1.2 without the regulation variable to negative 1.5 with it. Private firms operating under stringent conditions performed even worse than the state-owned monopolies: the coefficient on the regulation variable is negative 1.65. In other words, European countries with state-owned monopolies had 1.5 fewer phones per hundred people, on average, though countries that allowed private firms to operate only under restrictive conditions had almost 1.7 fewer phones per hundred. While the "capricious regulation" results are sensible—no rational firm would invest much if it knows its investment will be seized—they should nonetheless be viewed carefully here. In practice, for 1913 this variable applies only to Italy and Spain, where other factors may have inhibited telephone development. The panel analysis below will deal with this issue.

Rural service

An important part of the question of telecom reforms today is who can expect to receive service under a liberalized market environment. A common rationale for government provision of telecommunication services both today and in the past is that rural areas would not be served in a private, competitive market. The AT&T (1913) data separates telephone penetration information for each country into the average penetration rate in cities of over 100,000 people and the penetration rate outside the cities. While the rate outside those cities might include suburban areas, which we would today not call rural, I use the rate outside the cities as a measure of rural penetration, and run the same regressions as above.

Table 5 shows the results of these regressions. Again, the regressions reveal a strongly negative effect of state monopoly telephone provision. The concern that the private sector would not provide service to rural areas seems completely unfounded; indeed it was the state monopolies that did not serve rural areas. The main reason for this result is the large number of local cooperatives that formed in rural areas to provide service when it was allowed. Service provided by cooperatives was often not of high quality, though presumably low-quality telephony was better than no telephony.

Telephone penetration: panel data 1892-1914

One potential shortcoming with the above regressions is that they use cross-sectional data. As a result, it is not possible to control for country fixed effects, which could impact telephone development. For example, the "capricious regulation" variable applies only to Italy and Spain in the 1913 regressions, meaning that the variable could simply be picking up factors unique to those countries suppressing telephone development but unrelated to the concessions, *per se*. The panel data allows me to control for country (and year) fixed effects, as well as adding the UK to part of the sample with capricious regulations, since prior to 1911 service was provided by a private firm operating under the assumption that its assets would essentially be confiscated in that year.

The unbalanced panel includes 17 countries for certain years 1892-1914, yielding 54 country-year observations. Table 6 lists the countries included in the panel and the years for which data are available. I use this panel to re-estimate the equation presented above, this time allowing the introduction of fixed effects. Table 7 shows the results of these regressions. The first two columns show exactly the same regressions as above (i.e., no fixed effects), with identical results. Penetration is worse under state-owned monopolies than under private competition, and even worse under private provision with capricious regulations. The last three columns of the table slowly introduce the fixed effects, first estimating the equation with country fixed effects, then year, and then both. The results remain unchanged: both state-owned monopoly service and capricious regulations yield relatively poor telephone penetration.

Long-distance prices

Comparing prices of telecommunications services even today is difficult, and prices a century ago were no simpler. As discussed above, pricing structures differed radically across countries, making comparisons difficult. Some countries charged a connection fee to establish service while others did not, some maintained a flat rate for local service while others introduced measured service fairly early, and so on. Nonetheless, it is possible to compare one element of price: long-distance service, as discussed above. I use that price data to estimate several versions of equation (2).

$$(2) \quad \textit{long distance price}_i = \beta_0 + \beta_1*(\textit{government monopoly}_i) + \beta_2*(\textit{capricious regulations}_i) + \beta_3*(\textit{gdp per capita}_i) + \varepsilon$$

I estimate this equation three times: once with the dependent variable defined as the per-minute price of a 40-mile call, once for an 80-mile call, and once for a 160-mile call.

Table 8 shows the results of this series of regressions. In this case, per capita income is not significant. Long distance prices under state-owned monopolies are higher than under service provided in countries with private service and competition. Capricious regulations were associated with much higher prices. Indeed, the threat of government takeover without compensation added more than twice the amount that state-ownership added to the average price of a 160-mile call. This result is not surprising: a firm that must recoup all of its costs—marginal and fixed—in a short period of time will have to charge higher prices in the short time it has.

Discussion

Most research studying modern telecommunications reforms use information beginning in the 1980s at the earliest, when almost every country in the world save the United States had a state-owned monopoly telecom provider. In many ways this is sensible: consistent empirical data does not go back much further, and, in any event there was little change in sector structure between the end of the Second World War and the late 1980s. Case studies of telecom reforms, meanwhile, provide detailed information on the politics and institutions factored into reform decisions, and the very early history may be less relevant in these cases. Nonetheless, it is a mistake to ignore the early history of the telephone industry.

Many countries today are wary about liberalizing their telecommunications sector, believing that liberalized markets are untested in telecommunications. Policy makers worry that such reforms could lead to high consumer prices and that a competitive market would underserve rural areas. But telephone service was not born as a state-owned enterprise around the world.

Different countries took different approaches to the new industry, with many allowing private firms and vigorous competition between those firms, and sometimes between private firms and a government provider. In other words, the world already has had some experience with liberalized telecom sectors, and we should use this information to help understand the effects of competition and monopoly in modern service.

The results in this paper for European countries are largely consistent with empirical analyses of reforms in developing countries today. Telephone penetration was worse under state-owned monopolies than under private, competitive provision. Moreover, prices for long-distance service were higher under state monopolies than in countries with more competitive environments. It is worth emphasizing that these results do not show benefits of private telephone provision, *per se*. Instead, they show the benefits of competition, which obviously (and a bit tautologically) can occur only in the presence of multiple firms. The fiercest competition in Europe took place in Stockholm, between a private firm and a state-owned operator, leading to telephone development that, for a time, exceeded US cities. Indeed, this is the one example outside the US where multiple firms competed within the same geographic region, to the great benefit of its residents.

One issue I have not discussed is interconnection. The well-known problem with multiple telephone networks is that subscribers of one network may not be able to reach subscribers of the other network. That precise situation developed in the United States once the Bell patent expired in 1894. A vast network of non-Bell firms (the "independents") quickly emerged. The independents were largely connected to other independents, while the Bell systems around the country were also connected to each other. The Bell and independent systems did not interconnect. Anyone who wanted access to both networks had to subscribe to both and thus have two telephones. Little is written about this issue in early European telephone networks, presumably because there were so few places where multiple networks overlapped geographically. In that case, the only issue was connecting regions via long-distance lines, which is inherently less difficult than compelling a firm to connect direct competitors to its network. Still, even without interconnection, the early benefits of competition seem clear: countries that licensed multiple private firms saw better telephone penetration than countries with state-owned monopoly providers, and Stockholm, which had two non-interconnected, geographically overlapping, providers for a time had probably the highest penetration rate in the world.

Summary and conclusion

While a good deal of empirical research today is beginning to investigate the effects of telecom reforms in developing countries, this paper steps back in time to explore the effects of different market structures on early telephone provision. In particular, I compile data from a wealth of sources to conduct empirical tests of the effects of government monopoly ownership and regulation on telephone penetration and long distance prices at the turn of the twentieth century. Analysis of cross-sectional and panel data reveals that telephone penetration was much lower in countries where service was provided by state-owned monopolies than in countries that allowed private firms to provide service. Countries that licensed private firms under stringent concessions (where the state retained the right to take over the firm's plant and equipment with no compensation), however, saw even worse telephone penetration. More surprisingly, the analysis also reveals that *rural service* was worse and long-distance prices higher under state monopoly provision.

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Figure 1

Telephones per hundred and GDP per capita, Europe 1914

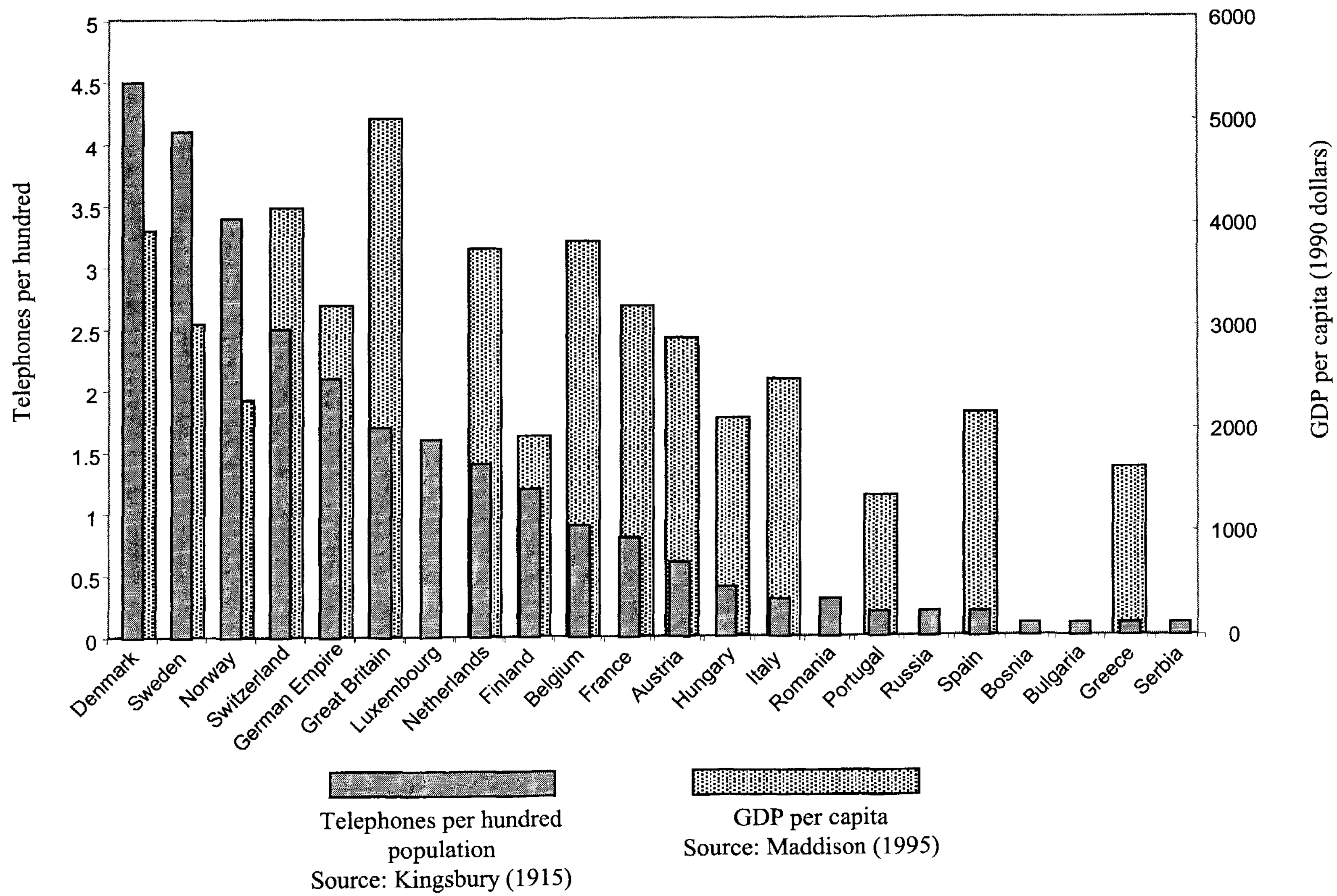

Figure 2
Telephones per capita, Europe 1885-1914

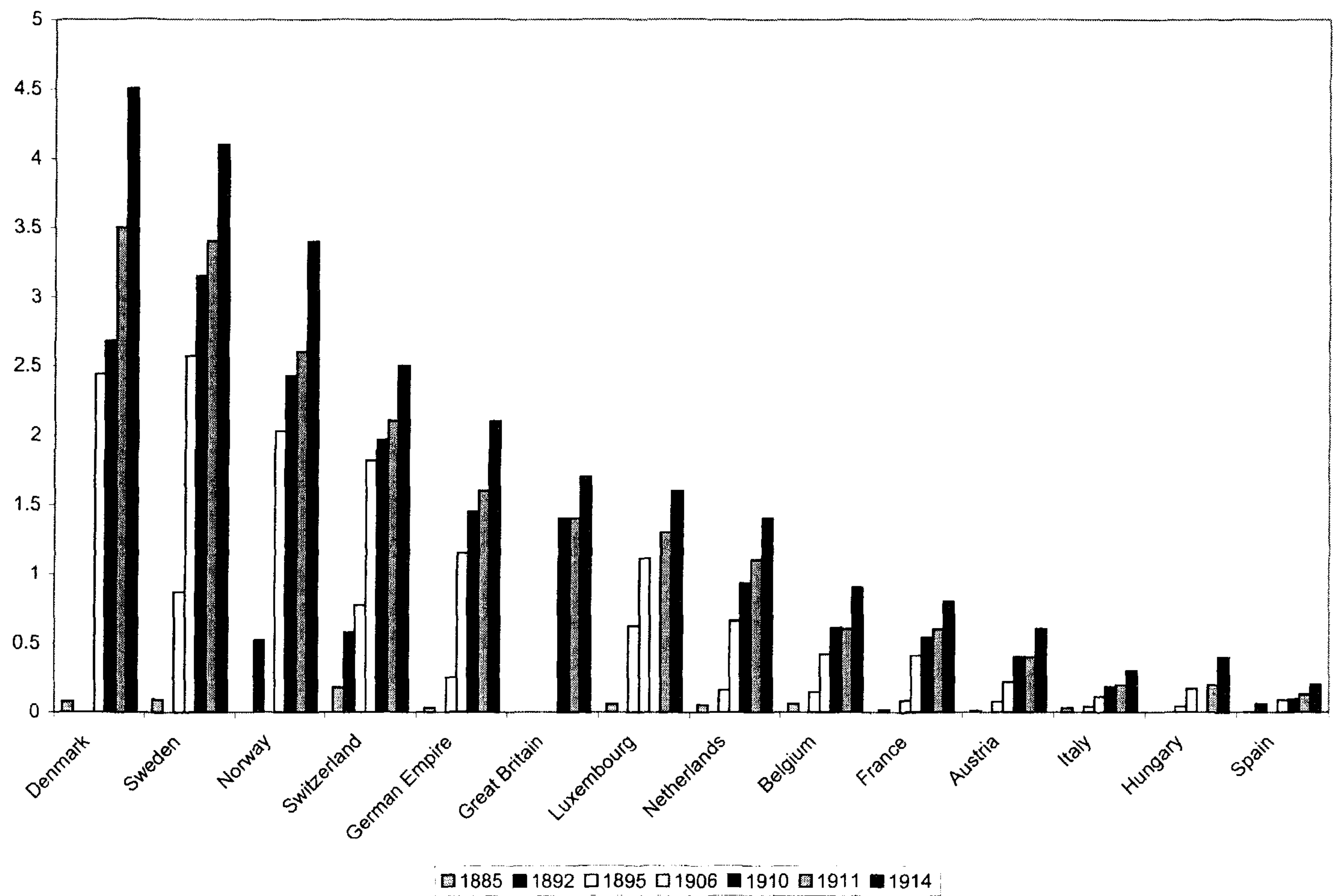

Figure 3
Telephone penetration in selected cities, 1889-1914

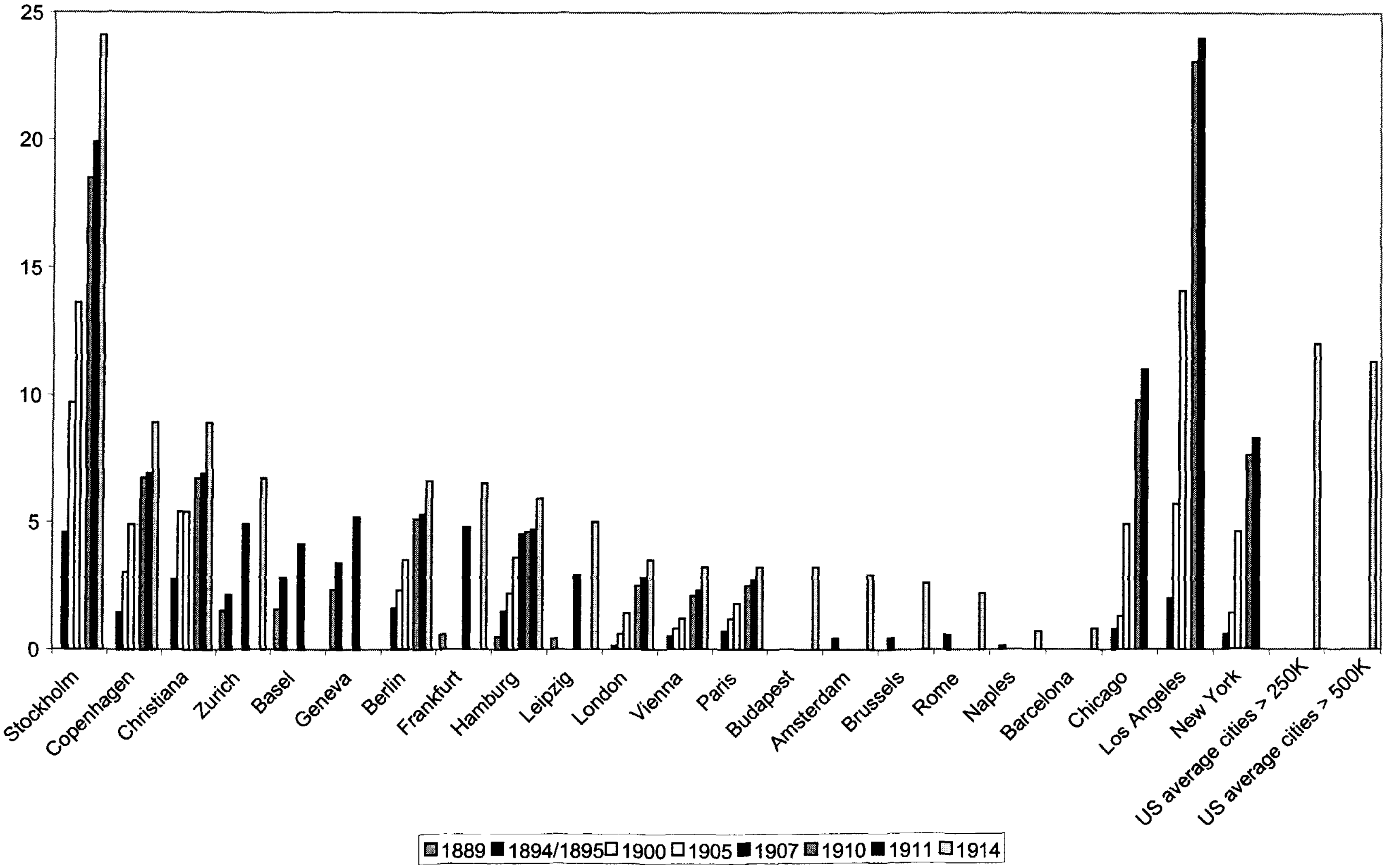

Figure 4
Telephone Density in Selected Cities in 1894

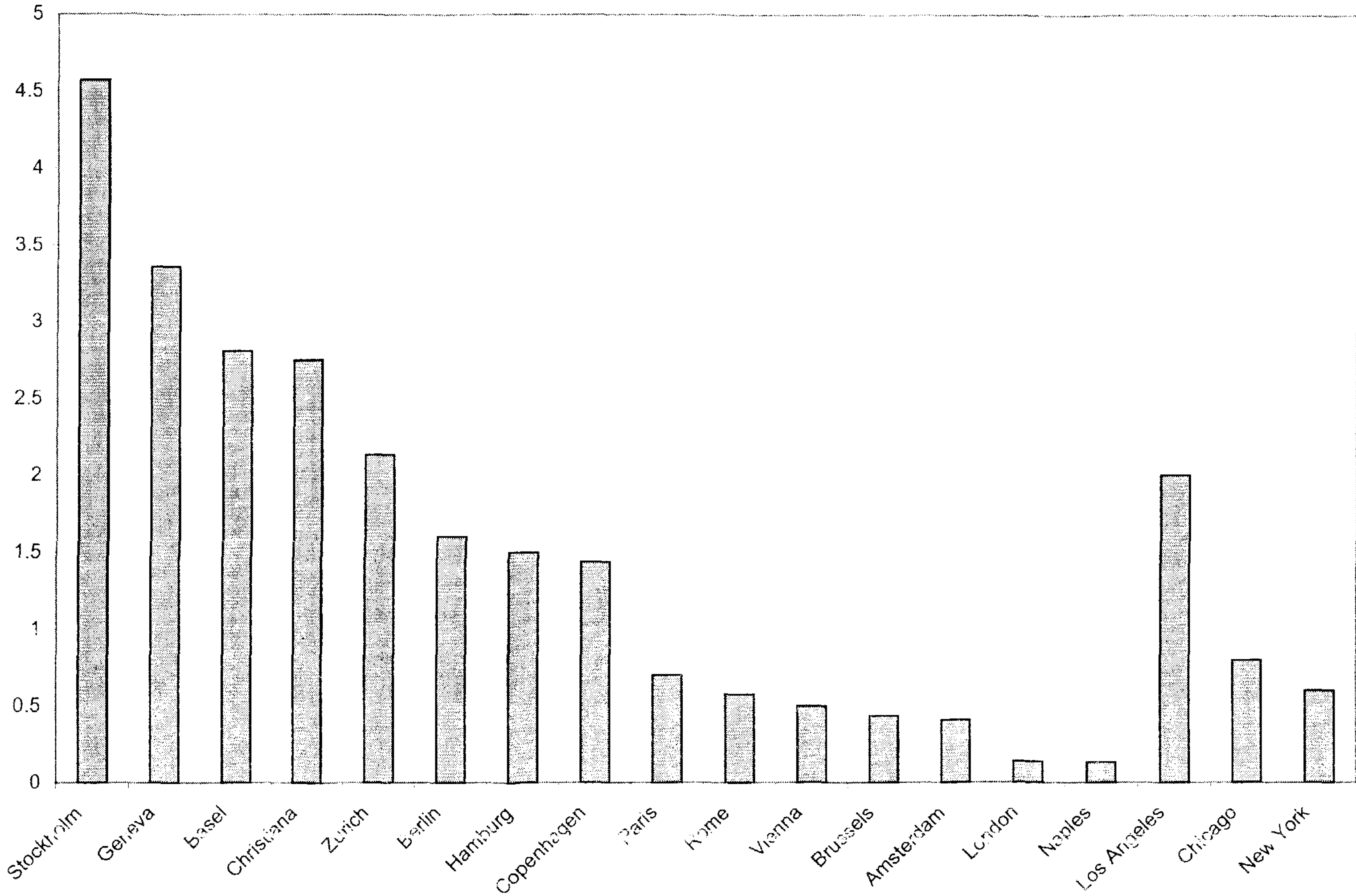

Table 1
Worldwide Telephone Statistics, January 1, 1914

Region	Country	Number telephones		Telephones per 100 population		
		Government	Private	total	urban	rural
North America	US	0	9,542,017	9.7	11.9	8.88
	Canada	106,183	393,591	6.5		
	Central America	4,326	3,548	0.1		
	Mexico	1,319	40,542	0.3		
	Other N.A.	20	2,318	0.7		
	Cuba	299	15,798	0.7		
	Puerto Rico	300	4,088	0.4		
	Other west indies	2,018	4,581	0.1		
Europe	Austria	172,344	0	0.6	2.8	0.3
	Bosnia	1,200	0	0.1		0.06
	Belgium	65,000	0	0.9	2	0.39
	Bulgaria	3,608	0	0.1	1.5	0.04
	Denmark	1,586	127,691	4.5	8.9	3.33
	France	330,000	0	0.8	2.6	5.2
	German Empire	1,420,100	0	2.1	4.9	1.29
	Great Britain	780,512	0	1.7	2.6	0.83
	Greece	3,200	0	0.1	0.3	0.06
	Hungary	84,040	0	0.4	3	0.27
	Italy	61,978	29,742	0.3	1.3	0.12
	Luxembourg	4,239	0	1.6		1.59
	Netherlands	76,267	10,223	1.4	3.2	0.84
	Norway	40,120	42,430	3.4	8.4	2.82
	Portugal	1,203	7,647	0.2	1.2	0.02
	Romania	20,000	0	0.3	1.5	0.2
	Russia (European)	157,710	162,148	0.2	2.1	0.08
	Finland	0	40,000	1.2	6.5	0.96
	Serbia	3,700	0	0.1		0.08
	Spain	2,722	31,278	0.2	0.6	0.12
	Sweden	158,171	74,837	4.1	18.6	2.62
	Switzerland	96,624	0	2.5	6.3	1.96
	Other places	1,485	904	0.1		0.09
South America	Argentina	0	74,296	0.9		
	Bolivia	0	2,500	0.1		
	Brazil	1,165	38,018	0.2		
	Chile	0	19,709	0.6		
	Colombia	0	3,177	0.1		
	Ecuador	481	2,445	0.2		
	Paraguay	129	370	0.1		
	Peru	0	4,000	0.1		
	Uruguay	0	13,599	1		
	Venezuela	341	4,688	0.2		
	Other places	1,413	0	0.3		
Asia	British India	6,504	11,193	0.01		
	China	13,517	13,492	0.01		
	Japan	219,551	0	0.4	1.5	0.26
	Russia (Asiatic)	9,423	7,181	0.1		
	Other places	22,110	3,114	0.01		
Africa	Egypt	4,949	12,310	0.1		
	South Africa	28,889	0	0.5		
	Other places	18,089	859	0.05		
Oceania	Australia	137,485	0	2.8	4.5	1.77
	Dutch East Indies	11,393	3,450	0.04		
	Hawaii	0	7,284	6.5		
	New Zealand	49,415	0	4.6	6.2	4.4
	Philippine Islands	1,779	4,979	0.1		
	Other places	1,371	225	0.1		
World Total		4,128,278	10,760,272	0.9		

Note: "Urban" is defined as cities with a population greater than 100,000.
Source: AT&T (1914), as reproduced in Kingsbury (1915)

Table 2
Services and Prices, Selected European Countries, 1895

Country	Entrance Fee (pounds)	Annual subscription (pounds)	2nd connection charge (pounds)	Internal trunk rates (pence)		Telephoning telegrams (pence)		Telephonograms (pence)			Telephoning mail matter (pence)		Pay phone	
				5 min call	20 min call	fixed	per word	fixed	marginal	per	fixed	per word	pence	minutes
Austria	4.17	4.17	4.38	10	40	1	0.1	1	0.1	word	1	0.1	2	3
Bavaria	0	7.5	7.71	5	20	0	0	1	0.1	word	1	0.1	2.5	5
Belgium	0	7.5	n/a	9.6	38.4	0	0	n/a	n/a		n/a	n/a	2.4	5
Bulgaria	0	7	n/a	9.6	38.4	n/a	n/a	n/a	n/a		n/a	n/a	4.8	5
Denmark-private	0	8.3	8.7	0	0	0	0.133	0	1.99	10 words	n/a	n/a	2	5
Denmark-state	0	8.3	8.7	20.4	81.7	2.6	0							
Finland	0	4	n/a	1	4	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a
France	0	16	16.3	4.8	19.2	480			4.8	5 min	n/a	n/a	4.8	5
Germany	0	7.5	7.8	8.3	33.3	1	0.1	1	0.1		1	0.1	2.5	3
Holland	0	9.7	n/a	16.5	66	0.99	0	n/a	n/a		n/a	n/a	4.95	5
Hungary	0	12.5	n/a	46.7	186.7	2		n/a	n/a		n/a	n/a	2	5
Italy	0	5.4	n/a	29	29	1.92		n/a	n/a		n/a	n/a	1.68	5
Luxembug	0	3.2	n/a	0	0	0.98		4.34			0.98		3.36	5
Monaco	0.6	6	n/a	0	0	0	0	4.8		5 min	n/a	n/a	2.4	5
Norway	0	4.4	4.6	3.3	13.2	2.6	0.1	4		30 words	n/a	n/a	1.3	5
Portugal	0	7.5	7.8	0	0	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a
Romania	6	8	n/a	14.4	14.4	0.96	0.1	4.8	1.9	20 words	n/a	n/a	9.6	5
Russia	0	25	n/a	0	0	n/a	n/a	n/a	n/a		n/a	n/a	n/a	n/a
Spain	0	8.8	n/a	8.8	35.3	n/a	n/a	1.9	0.5	5 words	n/a	n/a	1.92	3
Sweden-private	2.8	5.6	5.8	0	0	0	0	3.3		40 words	n/a	n/a	1.3	
Sweden-state	2.8	4.4	4.6	0	0	0.66	0	3.3		40 words	n/a	n/a	1.99	
Switzerland	0	4.8	n/a	4.8	19.2	0.96		1.9	0.1	word	n/a	n/a	0.96	3
Wurtemburg	0	5	5.14	5	20	1	0.1	1	0.1	word	1	0.1	2	5

Table 3

Long Distance Prices, pence per minute

Country									miles										
	20	40	80	120	160	200	240	280	320	360	400	440	480	520	560	600	640	680	720
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Finland	0.2	0.2	0.5	0.5	0.9	1.1	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Norway	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sweden	0.0	0.0	1.3	1.3	2.2	2.2	2.2	2.2	2.2	2.2	3.3	3.3	3.3	3.3	4.4	4.4	4.4	4.4	4.4
Switzerland	1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Belgium	0.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Bulgaria	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
France	1.0	1.0	1.9	1.9	2.9	3.8	3.8	4.8	5.8	5.8	6.7	7.7	7.7	8.6	9.6	9.6	10.6	10.6	11.5
Holland	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Germany	1.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Spain	2.2	2.2	4.0	4.0	5.6	7.2	7.2	8.1	10.4	10.4	12.0	13.6	13.6	15.1	16.7	16.7	18.3	18.3	20.6
Austria	2.0	3.3	4.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
United Kingdom	2.0	3.0	5.0	7.0	9.3	11.3	13.3	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	39.3	41.3
Italy	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	6.9	6.9	8.1	9.2	9.2	10.4	11.6	11.6	12.7	12.7	13.9
Hungary	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7

Derived from Bennet (1895), p.16

Table 4
Market Structure and Telephone Penetration
(absolute t-statistics in parentheses)

Dependent variable	telephones per hundred population		
Mean of dependent variable	1.4	1.26	1.26
	World	Europe	
Intercept	-0.83	-0.25	0.18
	(1.73)	(0.34)	(0.26)
Government monopoly	-1.48	-1.19	-1.54
	(2.86)	(2.18)	(2.95)
Capricious regulations			-1.65
			(2.08)
GDP/cap ($000)	1.07	0.73	0.70
	(6.37)	(2.90)	(3.10)
R-squared	0.58	0.4	0.54
F-test zero slopes	20.5	5.04	5.56
Num observations	33	18	18

Table 5
Rural Service
(absolute t-statistics in parentheses)

Dependent variable	telephones per hundred population outside largest cities	
Mean of dependent variable*	1.24	1.240
Intercept	-0.31	-0.005
	(0.70)	(0.01)
Government monopoly	-0.86	-1.09
	(2.49)	(3.29)
Capricious regulations		-1.09
		(2.09)
GDP/cap ($000)	3.81	3.64
	(3.84)	(4.04)
R-squared	0.73	0.8
F-test zero slopes	8.5	8.6
Num observations	18	18

* Note: Urban mean = 4.38

Table 6
Countries and Years in Panel

Country	years	government monopoly?
Austria	1895, 1906, 1913, 1914	yes
Belgium	1895, 1906, 1913, 1914	yes
Bulgaria	1913	yes
Denmark	1906, 1913, 1914	no
Finland	1913, 1914	no
France	1895, 1906, 1913, 1914	yes
Germany	1895, 1906, 1913, 1914	yes
Great Britain	1910, 1913, 1914	no prior to 1911
Greece	1914	yes
Hungary	1895	yes
Italy	1895, 1906, 1913, 1914	no
Netherlands	1895, 1906, 1913, 1914	no
Norway	1892, 1906, 1913, 1914	no
Portugal	1913	no
Spain	1892, 1906, 1913, 1914	no
Sweden	1895, 1906, 1913, 1914	no
Switzerland	1895, 1906, 1913, 1914	yes

Table 7
Market Structure and Telephone Penetration
(t-statistics in parentheses)

Dependent variable: telephones per hundred, mean = 1.16	No fixed effects		Country fixed effects	Year fixed effects	Country-year FE's
Constant	-0.14 (0.31)	0.61 (1.39)			
Government monopoly	-1.05 (3.46)	-1.52 (5.33)	-2.25 (4.43)	-1.41 (4.87)	-1.09 (1.95)
Capricious regulations		-1.59 (4.23)	-2.14 (2.43)	-1.58 (3.99)	-2.61 (5.30)
Per cap income	0.61 (3.94)	0.53 (3.89)	1.11 (4.60)	0.41 (2.67)	0.07 (0.18)
R-squared	0.29	0.48	0.85	0.55	0.9
F-test	10.37	15.16	9.01	5.96	9.4
Number observations: 54					

Table 8
Market Structure and Long Distance Prices, Europe
(absolute t-statistics in parentheses)

Dependent variable	per minute price of call distance		
	40 miles	80 miles	160 miles
Mean of dependent variable	1.91	2.97	3.7
Intercept	2.18	2.05	0.88
	(1.32)	(1.39)	(0.49)
Government monopoly	2.45	2.43	2.36
	(2.12)	(2.35)	(1.86)
Capricious regulations	2.94	3.83	5.37
	(2.16)	(3.15)	(3.62)
GDP/cap ($000)	-0.56	-0.37	0.26
	(0.89)	(0.65)	(0.38)
R-squared	0.38	0.52	0.76
F-test zero slopes	2.11	3.63	4.68
Num observations	14	14	14

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